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SUPERSEDING
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DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

RUNWAY END IDENTIFIER LIGHTING SYSTEM

(REIL)

1. SCOPE

1.1 Scope.- This specification covers the requirements of the Federal Aviation Administration for a Runway End Identifier Lighting System (REIL) consisting of two flashing lamp assemblies and associated equipment at the approach end of runways.

2. APPLICABLE DOCUMENTS

2.1 FAA documents.- The FAA specifications, standards, and drawings of the issues specified in the invitation-for-bids or request-for-proposals form a part of this specification.

2.1.1 FAA specifications

FAA-E-1100	Photometric Test Procedures for Flashing Lamps
FAA-G-2100c	Electronic Equipment, General Requirements
FAA-D-2494/1a	Technical Instruction Book Manuscripts: Electronic Equipment, Requirements for: Part I - Preparation of Manuscripts

FAA-D-2494/2a	Technical Instruction Book Manuscripts: Electronic, Electrical, and Mechanical Equipment, Requirements for: Part II - Preparation of Reproducible (Camera-Ready) Copy and Original Artwork.
AC 150/5345-7	Specification for L-824, Underground Electrical Cables for Airport Lighting Circuits
AC 150/5345-10	Specification for L-828, Constant Current Regulators
AC 150/5345-11	Specification for L-812, Constant Current Regulators
AC 150/5345-26	Specification for L-823, Plug and Receptacle, Cable Connectors
AC 150/5345-42	FAA Specification for L-857, Airport Light Bases, Transformer Housings, and Junction Boxes
AC 150/5345-47	Isolation Transformers for Airport Lighting Systems

2.1.2 FAA standards

FAA-STD-013	Quality Control Program Requirements
FAA-STD-021	Configuration Management (Contractor Requirements)

2.1.3 FAA drawings

C-6046	Frangible Coupling, Type 1 and 1A, Details
C-21216	Standard Nameplate

2.2 Military and Federal publications.- The following Military and Federal publications of the issues in effect on the date of the invitation-for-bids or request-for-proposals form a part of this specification.

2.2.1 Military specifications

MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-C-7989	Cover, Light Transmitting, for Aeronautical Lights, General Specification for
MIL-C-25050	Color, Aeronautical Lights and Lighting Equipment, General Requirement for
MIL-E-17555	Electronic and Electrical Equipment, Accessories, and Repair Parts, Packaging and Packing
MIL-I-46058	Insulating Compounds, Electrical (for coating printed circuit assemblies)
MIL-T-27	Transformers and Inductors (Audio, Power, and High Power Pulse), General Specification for

2.2.2 Military standards

MIL-STD-276	Impregnation of Porous, Nonferrous Metal Castings
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-461	Electromagnetic Emission and Susceptibility, Requirements for the Control of Electromagnetic Interference
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-471	Maintainability Demonstration
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production
MIL-STD-810C	Environmental Test Methods
MIL-STD-889	Dissimilar Metals

2.2.3 Military publications

MIL-HDBK-217b	Reliability Stress and Failure Rate Data for Electronic Equipment
MIL-HDBK-472	Maintainability Predictions
RADC-TR-75-22	Nonelectronic Reliability Notebook

2.3 Federal specifications

QQ-A-200/9	Aluminum Alloy Bar, Rod, Shapes, Tube, and Wire, Extruded, 6063
QQ-A-225	Aluminum and Aluminum Alloy Bar, Rod, Wire, or Special Shapes; Rolled, Drawn, or Cold Finished, General
QQ-A-250	Aluminum and Aluminum Alloy Plate and Sheet, General Specification for
QQ-A-591	Aluminum Alloy Die Castings
QQ-A-601	Aluminum Alloy Sand Castings
QQ-P-416	Plating, Cadmium (Electrodeposited)
QQ-Z-325	Zinc Coating, Electrodeposited, Requirements for
TT-E-489	Enamel, Alkyd, Gloss (for exterior and interior surfaces)

2.3.1 Federal standard

FED-STD-595 Color (requirement for individual color chips)

2.4 Other publications.- The following publications, of the issues in effect on the date of the invitation-for-bids or request-for-proposals, form a part of this specification.

2.4.1 National Electrical Manufacturers Association (NEMA)

NEMA 4 Watertight and Dusttight Indoors and Outdoors (Enclosure)

NEMA FA1-3.01 Vibration Testing

2.4.2 American National Standards Institute (ANSI)

ANSI C62.1 Quantities and Units Used in Electricity

2.4.3 American Iron and Steel Institute (AISI)

AISI Stain and Heat Resistant Steel, No. 13

(Copies of this specification and other applicable FAA documents may be obtained from the Contracting Officer in the office issuing the invitation-for-bids or request-for-proposals. The requests should fully identify material desired, i.e., standard, drawing, specification, and amendment numbers and dates. Requests should cite the invitation-for-bids, request-for-proposal, or contract involved cr other use to be made of the requested material.)

(Requests for copies of Military documents should be addressed to the Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.)

(Information on obtaining copies of Federal specifications and standards may be obtained from the General Services Administration office in Washington, D.C.; Atlanta; Auburn, Washington; Boston; Chicago; Denver; Kansas City, Missouri; New York; San Francisco; and Seattle.)

(Information on obtaining NEMA publications may be provided by the National Electrical Manufacturers Association, 2101 L Street, NW., Washington, D.C. 20037.)

(Information on obtaining ANSI standards may be provided by the American National Standards Institute, 70 East 45th Street, New York, New York.)

(Copies of AISI standards may be obtained from the American Iron and Steel Institute, 1000 16th Street, NW., Washington, D.C. 20036.)

3. REQUIREMENTS

3.1 Equipment to be furnished by the contractor.- The equipment to be furnished under this specification for each REIL system shall consist of the following items:

(a) Control cabinet (3.4.1), including lightning arresters

(b) 2 each identifier assemblies (3.4.2)

(c) Power adapter (3.4.3) (when applicable)

(d) Aiming device (3.4.4)

(e) Site spare parts (3.5)

(f) Instruction books (3.18.2)

3.2 Other equipment.- Equipment that is required for the REIL system but is not furnished under this specification includes frangible couplings; 2-inch electrical metallic tubing (emt) conduit; and 100 watt (W), 6.6/6.6 ampere (A) or 200 W, 20/6.6 A isolation transformers.

3.3 General functional requirements.- The runway end identifier flashing light units (hereinafter referred to as identifier units) will be used to indicate the approach end of a runway (see figure 1). One identifier unit shall be located on each side of the approach end of the runway and both units shall flash simultaneously twice a second. The runway end identifier system shall be controlled (on-off) by: (a) sensing the current in an existing runway edge lighting circuit, (b) activating a switch in the control cabinet (3.4.1), and (c) remote control. An isolation transformer shall be used to isolate the control circuit of the identifier units from the high voltage circuit of the runway edge lights. The identifier unit shall have the capability of being operated at three different intensities. Intensity setting of the identifier units shall be accomplished by switching capacitors in the individual control cabinet (3.4.2.3) or by other electrical methods. Two selector switches shall be installed in the control cabinet to energize/deenergize the identifier units, and to permit manual, automatic, and remote control operation of the identifier units. Power for the operation of the identifier units shall be derived from a 120/240 volt (V), 60 hertz (Hz) constant potential source.

3.4 System operating requirements.- The identifier units (3.4.2.4) will operate in conjunction with an existing runway edge lighting circuit that is a series circuit, powered by a constant current regulator. This series circuit may be either a high intensity runway light (HIRL) circuit having five different current steps or a medium intensity runway light (MIRL) circuit having three different current steps. Operation of the identifier units in the auto mode shall be accomplished automatically by sensing the current in the runway edge lighting circuit; when the runway edge lights are on, the REIL will be on. The system may also be operated manually or remotely, as specified in 3.4.1.4 and 3.4.1.5. System block diagrams are shown in figures 2 and 3.

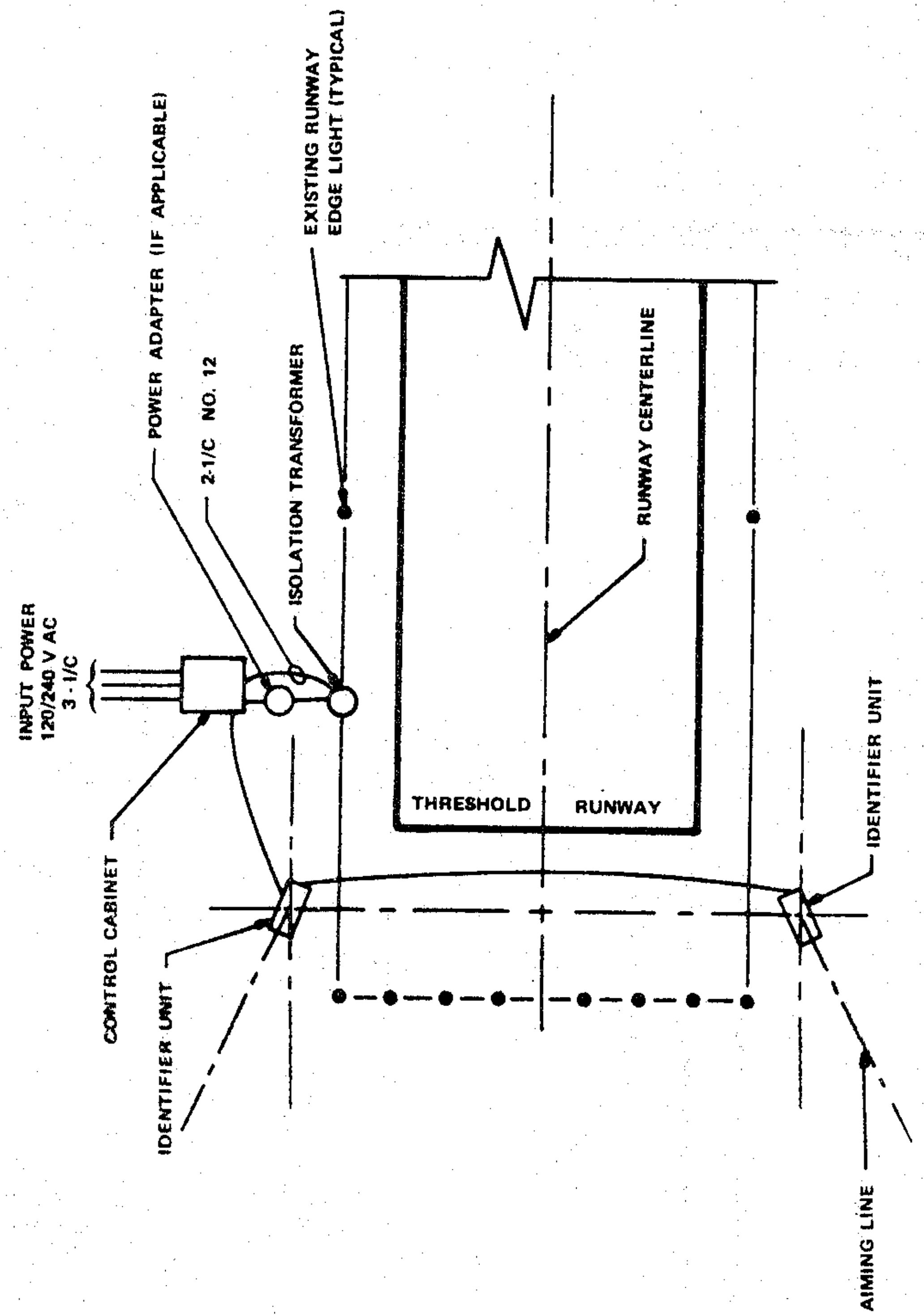

Figure 1. Runway End Identifier Lighting System (REIL)

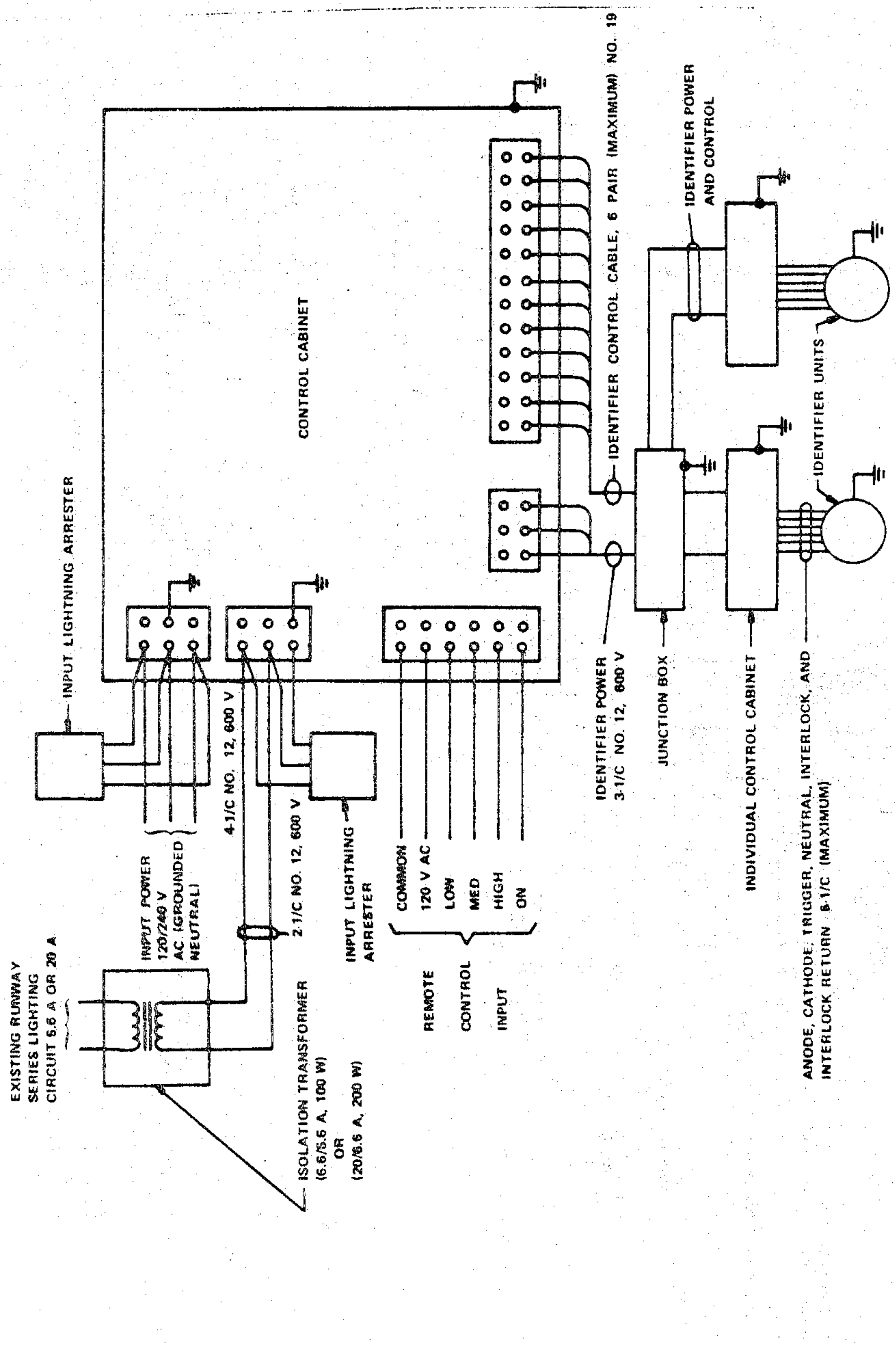

Figure 2. REIL Block Diagram

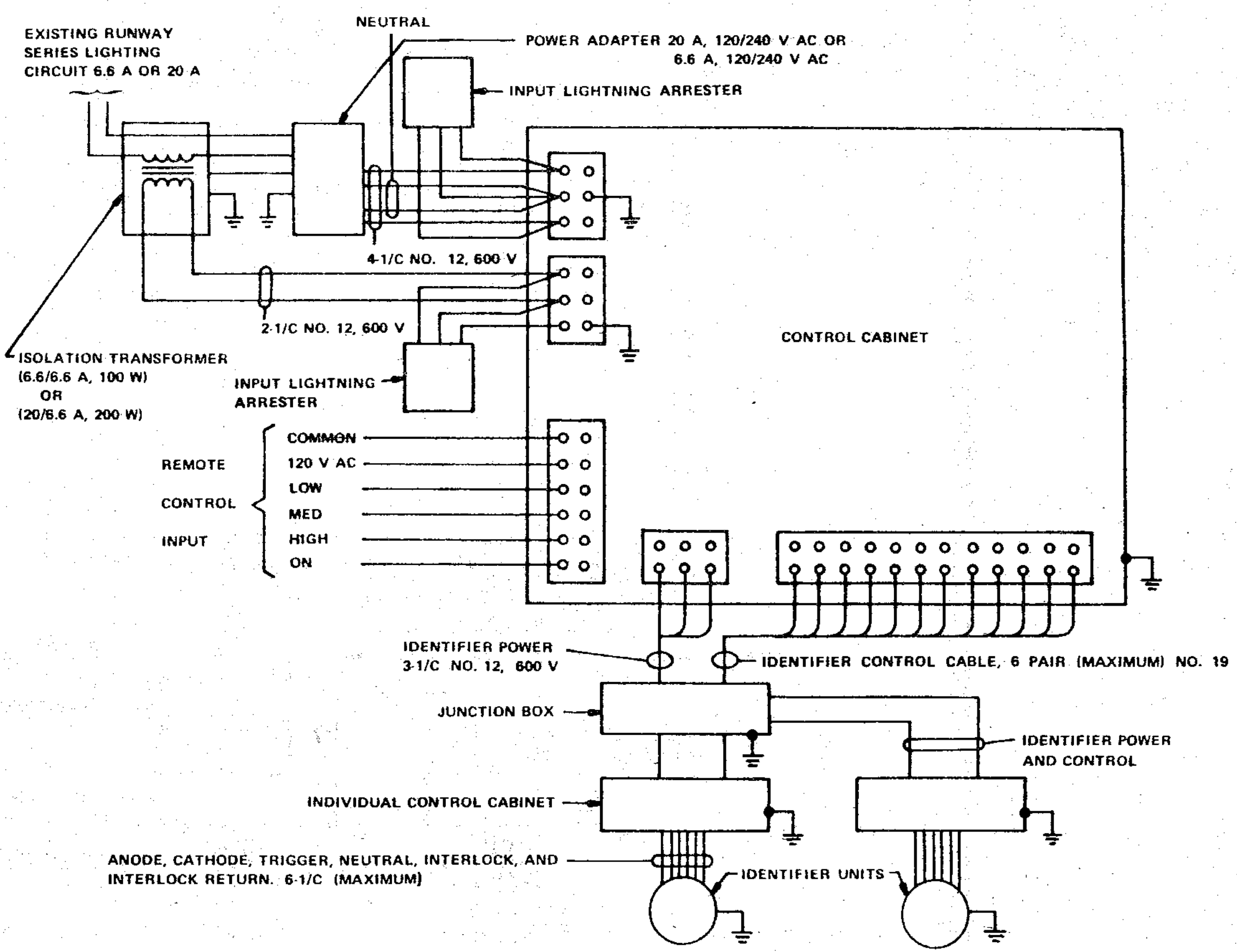

Figure 3. REIL Block Diagram (With Power Adapter)

3.4.1 Control cabinet.- The control cabinet shall be an outdoor, NEMA Type 4 enclosure of sufficient size to accommodate all of the necessary components and wiring. The cabinet shall be provided with adequate internal clearance to facilitate installation and maintenance of components. The cabinet housing shall be rigidly constructed and shall not distort or bend under normal methods of shipping, handling, installation, and maintenance. Either steel or aluminum may be used for the housing material. Aluminum, if used, shall be anodized in accordance with MIL-A-8625. The cabinet housing shall have a hinged door with provisions for padlocking (the hole for the padlock, furnished by others, shall be 7/16 inch (1.11 cm) in diameter). A lever handle shall be provided on the door to activate shoot bolts that will secure the door firmly in the closed position. Door gaskets shall be in accordance with 3.10.4. A door stop shall be provided to hold the door open at approximately 120°. A metal panel shall be installed in the rear of the cabinet upon which all components are to be installed. Mounting bolts shall not protrude through the cabinet. The cabinet shall be provided with suitable lugs to mount the cabinet in the vertical position. A ground lug having a slotted, hexagonal, green-colored head shall be provided in the cabinet for a No. 6 ground wire. Space shall be reserved for field installation of conduits for all external cable connections.

3.4.1.1 Power and control circuitry.- The control cabinet shall have the capability to detect misfires of identifier units accumulated over a 100-trigger sample interval. The number of misfires within the interval shall be compared to a threshold value set by thumbwheel switches located inside the cabinet. When the thumbwheel preset threshold value is exceeded, the identifier unit shall be considered failed and its corresponding failure signal shall be routed to the remote maintenance monitoring receptacle (3.9.7.1). The thumbwheel switches shall allow the threshold value to be varied, in integer numbers, from 1 to 7. Once the threshold has been exceeded, the failure detection circuit shall not be reset until either the reset pushbutton or the on/off selector switch is actuated. No additional wiring to the identifier units shall be required for this failure detection function. In addition, the control cabinet shall receive monitoring signals from the individual control cabinet (3.4.2.3) that will convey the operational status of the flash tubes to the remote maintenance monitoring system. The control cabinet shall provide 120/240 volts, three-wire, 60 hertz power, and the following control signals to each individual control cabinet via the junction box.

(a) One trigger signal

(b) One trigger signal return

(c) Three intensity signals (high, medium, and low)

(d) One intensity signal return

One signal return (ground) may be used instead of two signal returns for both the trigger and the intensity signals. The voltage used for the control signals shall not exceed 120 volts AC/DC. The current flowing through the control cable (figure 2) shall not exceed 500 milliamperes (mA).

3.4.1.2 Intensity step changing.- All identifier units shall be designed for three intensity levels (high, medium, and low). Complete instructions on accomplishing intensity level change shall be included in the equipment instruction book. Intensity step changing of the identifier units will be controlled from the control cabinet (3.4.1). In order to effectively switch flash capacitors, the control cabinet may automatically interrupt power to the identifier units for a period not to exceed 2 seconds during intensity step changing. In the event of loss of intensity step control voltage, the identifier units shall automatically revert to operation on the low intensity step. The design shall be such that no arcing or relay operations occur during any intensity step change. Components used for intensity step changing shall be designed for a minimum of 150,000 operations.

3.4.1.3 Current sensing switch.- A current sensing switch shall be provided in the control cabinet to control automatically the on-off operation of the identifier units in the AUTO mode (3.4.1.4). This shall be accomplished by sensing the current in a runway edge lighting circuit. The input to the current sensor will be obtained from the secondary of either a 100 watt, 6.6/6.6 ampere or a 200 watt, 20/6.6 ampere, 5 kilovolt (kV) isolation transformer (in accordance with AC 150/5345-47). The primary of the isolation transformer will be connected to the runway edge lighting circuit. The current sensor switch shall operate properly when located between 100 to 1,500 feet (30.5 to 457 meters) from the isolation transformer, when the transformer and switch are connected by 2-conductor No. 12 cable. (The isolation transformer and cable are not furnished under this specification, but one or more of the transformers will be required for factory tests.) The current sensor shall sense the current from the isolation transformer. This current will differ from a sine wave in various degrees, depending upon the number of burned out lamps in the runway edge lighting circuit. The design of the current sensor shall provide protection of solid-state components from lightning, current surges, and voltage surges of 1,500 volts peak-to-peak, 60 Hz, as may be encountered in a series lighting circuit. The current sensing switch shall contain an adjustable time delay of 0 to 4 seconds. This time delay will permit uninterrupted operation of the identifier units when they are used with runway lighting circuits in which the current is interrupted during intensity step changes.

3.4.1.3.1 Operation of current sensing switch.- The switch shall operate over a range of 0.5 to 7.0 amperes root-mean-square (rms) on the runway edge lighting circuit with an input voltage to the control cabinet of 120/240 V ac ±10 percent. The identifier units shall be shut off when the current in the runway edge lighting circuit drops below 0.5 amperes rms.

3.4.1.4 Control switches.- Two switches shall be installed in the upper right quadrant of the control cabinet to permit on/off, automatic, local, and remote control operation of the identifier units. The first switch, labeled IDENTIFIERS , shall be a two-position switch (ON-OFF) capable of turning the identifier units on/off, as indicated below:

Switch Position		Function
IDENTIFIERS	ON	Identifier units are energized.
	OFF	Identifier units are deenergized.

The second switch shall be a labeled five-position switch providing for step control of the system, beginning with the REMOTE function, as the selector knob is rotated clockwise as indicated below:

Switch Position		Function
REMOTE		Identifier units remotely controlled.
AUTO		Identifier units operate automatically in conjunction with runway lighting circuit.
	LOW	Identifier units operate on low intensity.
LOCAL	MEDIUM	Identifier units operate on medium intensity.
	HIGH	Identifier units operate on high intensity.

Play and backlash in the switches shall be held to a minimum, commensurate with intended operational functions, and shall not cause poor contact or inaccurate settings. Each functional position shall be identified by a mechanical stop, as well as by a position. Table I shows the intensity levels of the identifier units as a function of the loop current in the runway lighting circuit, when the selector knob is rotated to the AUTO position.

Table I. Runway Lighting Circuit Loop Currents and Identifier Intensity Levels

Runway Lighting Circuit	Loop Current (Amperes)	Identifier Intensity Levels
	6.6 ± 3%	High Intensity
MIRL	5.5 ± 3%	Medium Intensity
	4.8 ± 3%	Low Intensity
	6.6 ± 3%	High Intensity
	5.2 ± 3%	High Intensity
HIRL	4.1 ± 3%	Medium Intensity
(6.6 ampere	3.4 ± 3%	Low Intensity
circuit)	2.8 ± 3%	Low Intensity
	20.0 ± 3%	High Intensity
	15.8 ± 3%	High Intensity
HIRL	12.4 ± 3%	Medium Intensity
(20 ampere	10.3 ± 3%	Low Intensity
circuit)	8.5 ± 3%	Low Intensity

3.4.1.5 Remote control circuitry.- External remote control input signals to the control cabinet shall be 120 V ac, 500 mA (maximum). A terminal block meeting the requirements of 3.4.1.12 shall be provided in the lower left quadrant of the control cabinet for remote control input. The terminal block shall have two spare terminals, in addition to the six terminals designated below:

(a) Neutral

(b) 120 V ac

(c) Low intensity

(d) Medium intensity

(e) High intensity

(f) Identifiers on/off

The neutral terminal (a) shall be connected to the neutral bus. The (b) terminal shall be connected by a separately fused (10 ampere fuse) line to a 120 V ac source within the control cabinet. The (c) terminal is energized (120 V ac) by external control when either the low, medium, or high intensity step is selected. When terminal (c) alone is energized by external control, the identifer units shall turn on to the low intensity step. Terminal (d) is energized (120 V ac) by external control when either the medium or high intensity step is selected. When terminal (d) and terminal (c) only are energized, the identifier units shall turn on to the medium intensity step. Terminal (e) is energized (120 V ac) by external control when the high intensity step is selected. When terminal (e), terminal (c), and terminal (d) are energized, the identifier units shall turn on to the high intensity step. Terminal (f) is energized (120 V ac) by external control to turn the identifier units on. When terminal (f) is energized, the identifier units shall turn on to the intensity step determined by inputs to terminals (c), (d), and (e). Deenergizing of terminals (c), (d), and (e) shall turn off the identifier units. The system, when energized from the off position, shall come on at low intensity and then switch to a higher intensity if a higher intensity is selected. All intensity changes shall be completed within 1.5 seconds of initiating the intensity change. The power output to the identifier units may be interrupted up to a maximum of 1.5 second, if required, during intensity step change operations. Circuitry shall prevent intensity step changing during the discharge of an identifier assembly capacitor.

<u>3.4.1.6 Entrance switch</u>.- A two-pole, 30 A, 240 V ac, heavy duty, dead-front safety switch box equipped with a 30 A, two-pole, thermal-magnetic circuit breaker shall be provided as the primary disconnecting device in the 240 V ac input service. The operating mechanism shall be quick-make and quick-break. The switch box shall be mounted in the control cabinet at a location that will provide easy and safe access to the operating handle.

<u>3.4.1.7 Contactors</u>.- Lighting-type contactors of adequate rating and suitable for the intended application shall be provided for on-off switching of power to the identifier units. The contactors shall be controlled by the current sensor switch specified in 3.4.1.3.1, or by the on/off control switch described in 3.4.1.4. The contactors shall be installed so that their operation does not adversely affect other components.

<u>3.4.1.8 Master timer</u>.- A timer shall be installed in the control cabinet to provide simultaneous pulses for the identifier units. The timer shall provide a pulse not to exceed 120V AC/DC to each identifier individual control cabinet. The timer shall operate the identifier units as specified in 3.4.2.3.

<u>3.4.1.9 Elapsed time meter</u>.- A recycling type elapsed time meter shall be installed in the control cabinet to indicate the number of hours of operation. The meter shall indicate up to 99,999.9 hours and shall indicate total time in hours and tenths of hours.

3.4.1.10 Maintenance light and convenience outlet.- A 100 watt, 120 V ac light with a protective wire mesh cover shall be installed in the control cabinet to provide adequate illumination for nighttime maintenance operations. The light shall have an on-off switch that is easily identifiable in the dark and shall be properly fused. Both the light and receptacle shall be usable even though the entrance switch, 3.4.1.6, is open. A 120 volt, single phase, 15 ampere, grounding type receptacle, with built-in ground fault interrupter fused at 15 amperes, shall be installed in the control cabinet for maintenance purposes.

3.4.1.11 Lightning arresters.- Suitable lightning arresters shall be installed in the control cabinet to protect each input and output power terminals and each output control signal. The lightning arresters shall be wired to the terminal blocks specified in 3.4.1.12.

3.4.1.12 Terminal blocks.- All external connections shall terminate on terminal blocks of adequate size and voltage rating. The terminal blocks shall be the enclosed base type with pressure-plate type terminal connectors. All terminals shall be shielded to prevent accidental contact, and shall be marked as required in Specification FAA-G-2100c.

3.4.2 Identifier assembly.- An identifier assembly shall consist of an individual control cabinet and a flasher light unit (identifier unit).

3.4.2.1 Photometric requirements.- The identifier units shall produce light intensities as shown in table II.

Table II. Light Intensities

Intensity Setting	Maximum Allowable Effective Intensity (Candelas)	Minimum Effective Intensity (Candelas)
High	20,000	8,000
Medium	2,000	800
Low	450	150

The effective intensity measurements shall be made over a rectangular pattern not less than 10° vertically and 30° horizontally. Corners may be rounded on a 5° radius to determine compliance with table II values. After 250 hours of continuously flashing twice per second, the lamp shall produce an effective intensity of no less than 70 percent of initial candlepower, and consecutive misses shall be no more than 1 percent. Flash duration shall not be less than 250 microseconds nor more than 5,500 microseconds at 50 percent of the peak instantaneous candlepower. The optical system shall be as simple as possible and still meet all other pertinent requirements. The system may consist of reflectors, lenses, prisms, or such other elements necessary to obtain the required light output. All optical elements shall be designed to assure a long life and consistency of photometrics. The lamp and all optical parts shall be firmly held in place to withstand shock and vibration, but shall permit convenient lamp replacement when required. The optical system shall be designed to prevent misalignment during maintenance operations.

3.4.2.2 Rating.- Each identifier unit shall not consume more than 500 volt-amperes at 240 volts, when measured with thermal meters giving a steady needle deflection or with a watt-hour meter. The surge current at each flash shall not exceed 9 amperes (rms) at 240 volts. The identifier assembly shall be capable of operating from a 120/240 V ac source.

3.4.2.3 Individual control cabinet.- The triggering circuit of each identifier unit shall be located in the individual control cabinet. The trigger transformer may be located in the identifier unit. The identifier units shall flash simultaneously twice a second. The trigger circuit of each identifier unit shall be energized from the control cabinet and as determined by the master timer (3.4.1.8). A current detection device that will monitor the operation of the flash tube when a trigger pulse is received from the control cabinet, shall be incorporated in the design of the individual control circuitry. The output signal of the detection device shall be routed to the control cabinet, via the junction box, and through two 1-conductor cables. The individual control cabinet shall operate satisfactorily when located up to 3,000 feet (914.4 meters) from the master controller. The design of the triggering circuits shall be such that failure of one unit will not affect operation of the remaining unit. Components used in the triggering circuit shall be designed for a minimum of 50 million operations.

3.4.2.3.1 Power and control circuitry.- Output power and control signals from the individual control cabinet to the identifier unit shall be supplied through six wires designated as:

(a) Anode, No. 10 THWN (maximum)(Signal to anode of identifier flash tube)

(b) Cathode, No. 10 THWN (maximum)(Signal to cathode of identifier flash tube)

(c) Neutral, No. 10 THWN (maximum)

(d) Trigger, No. 14 THWN (maximum)(Signal to ionize the identifier flash tube)

(e) Interlock, No. 18 American Wire Gage (AWG) (Signal to interlock switch)

(f) Interlock return, No. 18 AWG (Return signal from interlock switch)

3.4.2.3.2 Lightning arresters.- Suitable lightning arresters shall be installed in the individual control cabinet to protect the input and output power terminals, as well as the input and output control signal terminals.

3.4.2.4 Identifier unit.- The identifier unit housing shall be constructed of stainless steel or aluminum, or of a nonferrous material which is comparable in service life to a stainless steel or aluminum housing over the full range of environmental and operating parameters defined in this specification. The identifier unit shall permit continuous vertical adjustment of the light beam axis from horizontal to 25° above horizontal. The horizontal beam axis shall be perpendicular to the lamp cover glass or window. All components in the identifier unit shall be accessible through a door or cover for maintenance purposes. Cable fittings shall provide both a waterproof and strain relief connection to the housing. The strain relief provided shall be as indicated in 3.4.3.7. The fittings shall not cause a permanent set on the cable insulation.

<u>3.4.2.4.1 Flash tube</u>.- The flash tube shall have a rated life of at least 1,000 hours when operated on the high intensity step. The effective intensity shall not decrease more than 30 percent during the minimum rated life, and flash skipping (misfirings) shall be less than 1 percent with no skips occurring consecutively. If the flash tube used is the type that is enclosed in a PAR-56 bulb, then the window (3.4.2.4.2) and reflector (3.4.2.4.3) are not required.

<u>3.4.2.4.2 Window</u>.- The housing shall have a glass window installed to permit the maximum amount of light transmission from the optical system lamp reflector. The glass shall be aviation white in accordance with MIL-C-25050 (Asg) and shall be Class A in accordance with MIL-C-7989. It shall be entirely free of bubbles, mold marks, or other imperfections which might impair light transmission. The glass shall be 1/4 inch (6.35 mm) nominal thickness and shall be highly resistant to mechanical impact and abrasion. The gasket surface of all glass shall be either ground or molded to a sufficiently true surface to ensure a tight joint. The window shall be attached to the housing by watertight gaskets and mounted in such a manner that it can be easily replaced from inside.

<u>3.4.2.4.3 Reflector</u>.- A metal reflector with reflective surface shall be used to provide the light output and beam spread specified in 3.4.2.1. The reflector shall have a minimum diameter of 7 inches (180 mm). The reflector material shall be brass or aluminum with a minimum finished thickness of 0.035 inches (0.88 mm) for brass and 0.060 inches (1.5 mm) for aluminum. Where aluminum is used it shall be provided with a clean anodized finish in accordance with MIL-A-8625.

<u>3.4.2.4.4 Socket</u>.- The lamp socket shall be a plug-in type porcelain socket able to withstand the operating temperature of the flasher lamp. Insulating materials used in the socket shall be nonporous and nonabsorbent. Screw terminals shall be provided on the socket for required wire terminations. The socket shall be attached to the lamp housing with two or more screws in a manner facilitating easy removal or replacement of the socket.

<u>3.4.2.4.5 Mounting attachments</u>.- Each identifier unit shall be assembled to a mounting base. The mounting base shall have an internal wireway for six wires to the lampholder. The lampholder/mounting base interface shall permit passage of the six wires mentioned in 3.4.2.3.1 regardless of the lampholder's vertical adjustment angle. The mounting base shall permit rigid mounting of the complete identifier unit by either capping the open top of a frangible coupling (FAA Drawing C-6046) or by capping the open top of a 2-inch (5.08 cm) electrical metallic tubing conduit. Three equally spaced (120°) 3/8-inch (0.95 cm) round-head stainless steel screws (with slightly cupped tips) shall be provided for this method of attachment.

<u>3.4.2.4.6 Baffles</u>.- The identifier units shall be designed to permit the mounting of baffles that will minimize or eliminate the blinding effect of the lights. Baffles shall be tested as an integral part of the identifier unit during qualification testing.

<u>3.4.3 Power adapters</u>.- Power adapters shall convert constant current power, received from an available medium intensity runway light (MIRL) system circuit or a high intensity runway light (HIRL) system circuit, to 120/240 V, ±10 percent, 60 hertz, constant potential power. Adequate power, a minimum of 0.7

kilowatt (kW), shall be produced to operate the control cabinet. Either a 6.6 ampere power adapter or a 20 ampere power adapter shall be used, depending on the nature of the runway edge lighting system circuit. The power adapter shall maintain the 120/240 V output over the entire current range of the runway lighting circuit. Figure 4 shows the REIL power adapter schematic wiring diagram.

3.4.3.1 The 6.6 ampere power adapter.- The 6.6 ampere power adapter shall convert constant current power that is provided from either a 6.6 ampere MIRL or a 6.6 ampere HIRL.

3.4.3.2 The 20 ampere power adapter.- The 20 ampere power adapter shall convert constant current power provided from a 20 ampere HIRL.

3.4.3.3 Power adapter design conditions.- The power adapters shall be designed to operate as specified without adverse effect on the edge lighting system when used in conjunction with runway edge lighting circuits described in 3.4.3.3.1, 3.4.3.3.2, and 3.4.3.3.3. The adapters shall be designed to operate as specified over the full regulator loading range, i.e., from a minimum of no other connected load (a power adapter and REIL system only) to a maximum load that is 1.0 kW less than the rated regulator capacity.

3.4.3.3.1 6.6 ampere MIRL design conditions.- The 6.6 ampere power adapter (3.4.3.1) shall operate as specified when used in conjunction with a MIRL system which has 1 spare kW of capacity. The constant current regulator shall be a 4 kW unit, Type L-812, in accordance with AC 150/5345-11. The connected load consists of (a) 9,000 feet (2,750 meters) of one-conductor No. 8 cable, type L-824, in accordance with AC 150/5345-7; (b) 52 each 30/45-watt isolation transformers, Type L-830-1, in accordance with AC 150/5345-47; (c) 40 each, 30-watt, 6.6 ampere lamps; and (d) 12 each, 45-watt, 6.6 ampere lamps. These loads produce a calculated total of 3.0 kW. For power adapter design purposes, assume a maximum of 10 percent of the lamps are burned out.

3.4.3.3.2 6.6 ampere HIRL design conditions.- The 6.6 ampere power adapter (3.4.3.1) shall operate as specified when used in conjunction with a HIRL system which has 1 spare kW of capacity. The constant current regulator shall be a 20 kW unit, Type L-828, in accordance with AC 150/5345-10. The connected load consists of (a) 13,000 feet (4,000 meters) of one-conductor No. 8 cable, Type L-824, in accordance with AC 150/5345-7; (b) 74 each, 200-watt, isolation transformers, Type L-830-6, in accordance with AC 150/5345-47; and (c) 74 each, 200-watt, 6.6 ampere lamps. These loads produce a calculated total of 19.0 kW. For power adapter design purposes, assume a maximum of 10 percent of the lamps are burned out.

3.4.3.3.3 20 ampere HIRL design conditions.- The 20 ampere power adapter shall operate as specified when used in conjunction with a HIRL system which has 1 spare kW of capacity. The constant current regulator shall be a 30 kW unit, Type L-828, in accordance with AC 150/5345-10. The connected load consists of (a) 17,000 feet (5,200 meters) of one-conductor No. 6 cable; (b) 94 each, 200-watt, isolation transformers, Type L-830-7, in accordance with AC 150/5345-47; and (c) 94 each, 200-watt, 6.6 ampere lamps. These loads assume a maximum of 10 percent of the lamps are burned out.

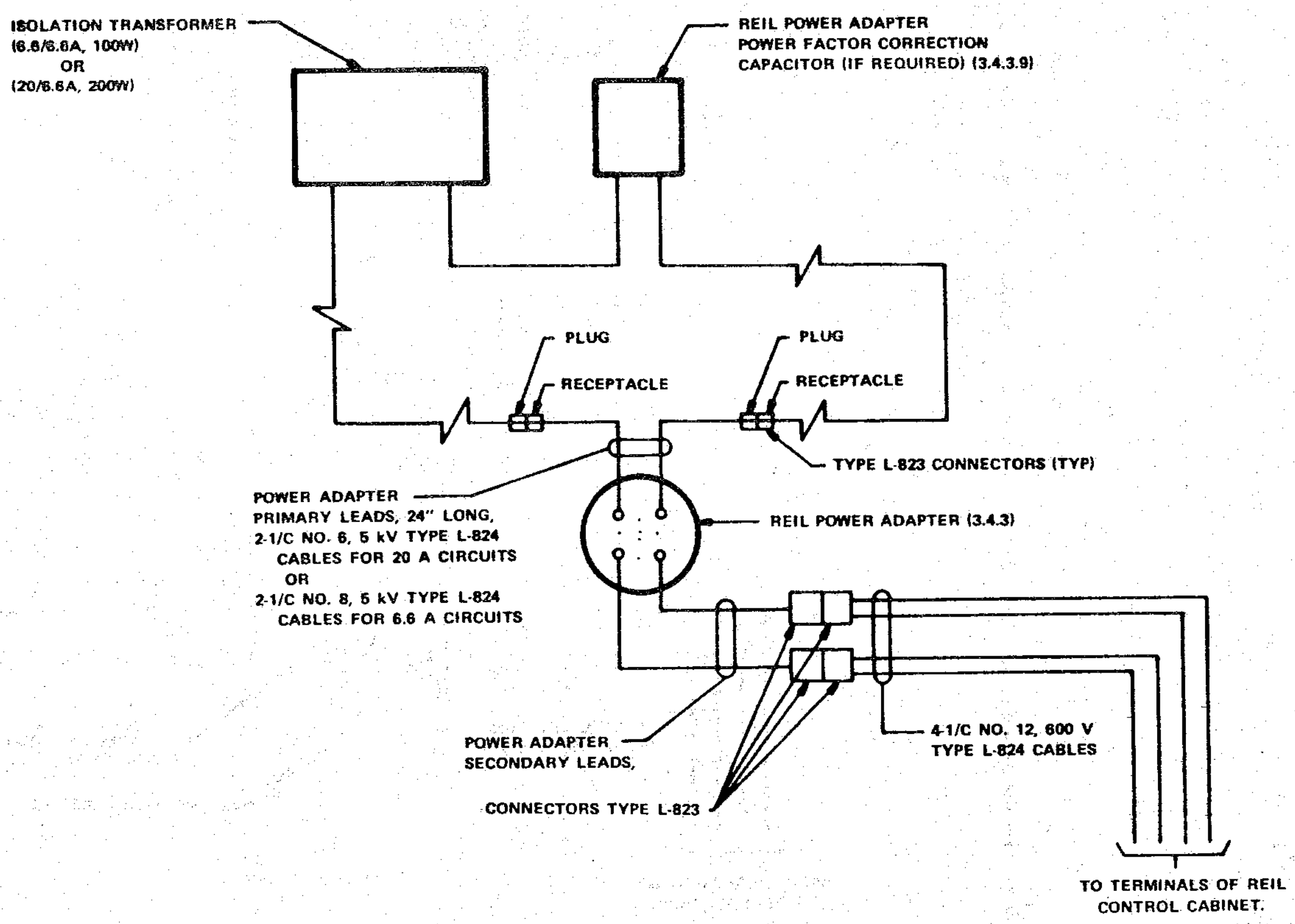

Figure 4. REIL Power Adapter Schematic Wiring Diagram

3.4.3.4 Power adapter housing.- The power adapter housing shall be a submersible, 1/3-inch (0.3 cm) thick minimum, welded, galvanized steel container with lid and O-ring gasket. The housing shall be cylindrical in shape and have a minimum 10 inch (2.5 cm) wide flange at the top. The lid shall be a minimum of 1/8 inch (0.3 cm) thick and shall be secured to the housing by a minimum of six bolts. The O-ring gasket shall be in accordance with 3.10.4. Two lifting handles, approximately 1/4 inch (0.6 cm) in diameter by 2 inches (5 cm) high by 5 inches (13 cm) wide shall be welded to the exterior surface of the lid. The housing shall be provided with a removable equipment mounting panel as specified in 3.4.3.8. Primary cables (3.4.3.5) and secondary cables (3.4.3.6) shall enter the housing through the lid, via squeeze fittings with waterproof glands. The entire power adapter, including primary and secondary cable leads and installation cables, shall fit into a Type I, 16 inch (40.64 cm), nominal diameter L-857 transformer housing with lid manufactured in accordance with AC 150/5345-42. Ancillary interface equipment, or components between the power adapter and the input terminals of the master control unit, shall not be required. The housing design shall provide for heat dissipation that is required to cool the adapter components, when they are operated under the specified environmental conditions and installed underground. No bolts shall pass through the exterior walls, bottom, or lid flange of the power adapter. All nuts, bolts, and washers shall be stainless steel. A minimum of three complete threads shall be used when bolts are in place.

3.4.3.5 Primary cables.- Primary leads from the power adapters shall be Type L-824 cable in accordance with AC 150/5345-7. The cables shall be 5 kV, one-conductor No. 6 cable for the 20 ampere power adapter; and 5 kV, one-conductor No. 8 cable for the 6.6 ampere power adapter. The primary leads shall be 24 inches (0.6 meter) long. One lead shall be equipped with a plug, Type L-823, and the other lead shall be equipped with a receptacle, Type L-823, in accordance with AC 150/5345-26.

3.4.3.6 Secondary cables.- Two secondary leads from either the 6.6 ampere or the 20 ampere power adapter shall be Type L-824 cable in accordance with AC 150/5345-7. The two leads shall be 600 volt, two-conductor, No. 12 cables, 48 inches (1.2 meters) long. Both secondary leads shall be equipped with a two-conductor, Type L-823 receptacle in accordance with AC 150/5345-26. Secondary cable conductors shall be permanently identified by brass tags securely attached to the cable adjacent to the receptacles. Four each, one-conductor, No. 12, Type L-824 cables up to 100 feet (30 meters) long with Type L-823 plugs will be furnished by another source to connect the power adapter to the control cabinet.

3.4.3.7 Cable installation.- Primary and secondary cables shall be adequately strain relieved on the inside surface of the power adapter lid to permit lifting of the entire power adapter by any one of the cables. Adequate slack cable shall be provided within the housing to permit the lid to be removed and placed flat on a work bench (at the same elevation as the bottom of the housing) without disturbing cable passages through the squeeze fittings.Cable penetration into the power adapter lid shall be waterproof.

3.4.3.8 Equipment mounting panel.- All power adapter components may be secured to a removable galvanized steel mounting plate via attached machine screws and slotted screw mounting holes. The panel shall be a minimum of 1/8 inch (0.3 cm) thick and shall be attached to the bottom of the housing, using a minimum of four standoff studs that are welded to the bottom of the housing, and lock washers and nuts. The panel shall have adequate clearance to be easily removed through the top of the housing with all components installed. Each component shall be removable without disassembly of any other components. All screws, nuts, washers, and bolts shall be of compatible stainless steel. A minimum of three complete threads shall be used when the screw, nut, or bolt is in place. Nuts to receive mounting screws shall be permanently secured to the mounting panel.

3.4.3.9 Power adapter transformer.- The power adapter transformer shall be the isolating type and shall have a minimum rating of 5 kV. The transformer may have power factor (pf) correction. The pf correction capacitor, when required, shall be installed in a separate NEMA 4 enclosure. The enclosure shall be made of stainless steel or aluminum and shall be designed for outdoor application. It shall be dust-tight and nonventilated, suitable for wall or floor mounting. The transformer shall be at least 90 percent efficient. Primary leads and windings shall be insulated from the core, the secondary windings, and all other components of the power adapter. The transformer shall be designed to operate indefinitely under load, short circuit, or open circuit conditions. The primary circuit shall be designed to withstand total immersion (the power adapter housing filled with water) without short circuiting. The transformer shall be designed to operate as specified when installed within the power adapter housing and subjected to the environmental conditions required. Power output shall be 120/240 volts $\pm$10 percent, 60 hertz, and shall be adequate to deliver, through the power adapter circuitry, all power required to operate the system as specified in 3.4.3. Cable penetrations between (pf) correction enclosure and the power adapter housing shall be waterproof. Any opening shall have gaskets in accordance with 3.10.4.

3.4.4 Aiming device.- The aiming device shall be designed to fit over the cover glass of the lamp and be held firmly in place by a pressure plate with adjustable spring tension. The aiming device shall permit field aiming of the lamp axis perpendicular to the plane of the cover glass to any angle from 0 to +25° above the horizontal. The aiming device shall be capable of aiming an identifier unit mounted on a frangible coupling (FAA Drawing C-6046). The aiming angle shall be indicated on a scale calibrated in 1° intervals and shall be accurate within $\pm$1/2° of the actual aiming angle with the device attached. The final aimed angle of the lamp with the device unattached shall be accurate within 1° of the actual angle.

3.5 Site spare parts.- One spare printed circuit board assembly of each type, complete with all components tested and operable, shall be provided for the master controller and the individual control cabinet. These parts shall be packed separately from the control cabinet and the individual control cabinet. The material used to wrap the site spare parts shall be static-free.

3.6 Environmental conditions.- The equipment shall be designed for continuous or intermittent operation outdoors under the following environmental conditions.

3.6.1 Temperature.- An ambient temperature between -55° Centigrade (C) (-67° Fahrenheit (F)) and +70° C (158° F).

3.6.2 Altitude.- Sea level to 10,000 feet (3,048 meters) mean sea level (msl).

3.6.3 Humidity.- Up to 95 percent relative humidity from sea level to 10,000 feet (3,048 meters) msl and +70° C ambient temperature.

3.6.4 Sand and dust.- Exposure to wind-blown sand and dust particles as may be encountered in arid regions.

3.6.5 Salt spray.- Exposure to salt-laden atmosphere with relative humidity of up to 95 percent.

3.6.6 Rain.- Exposure to wind-blown rain.

3.6.7 Solar radiation (sunshine).- Exposure to sunshine with ambient temperature as stated in 3.6.1.

3.6.8 Temperature shock.- Exposure of exposed surfaces (including light windows) to sudden application of cold water when the lights reach stable operating temperatures.

3.6.9 Vibration.- The equipment shall be capable of withstanding vibrations in the frequency range of 10 to 2,000 hertz in accordance with NEMA Standard FA1-3.01.

3.7 Transient suppression.- The equipment shall be designed to withstand transient increases in the 120/240 V ac (rms) line voltage superimposed on the ac line voltage waveform and reaching a peak voltage of 500 V for as long as 50 milliseconds. In addition, the equipment shall be designed to withstand lightning line transients applied at the equipment input and output power terminals that are characterized as 10 by 20 microsecond waveform current surges of 10,000 amperes with the subsequent power-followup and 1.5 by 50 microsecond voltage surges of 10 kV. The current and voltage surge waveforms are described in ANSI Standard C62.1. The equipment shall restart automatically if an interruption or shutdown is experienced due to either type of transient. Equipment operational functions shall be unimpaired by the above transients when each type of transient is imposed a minimum of five times each to the input and output power terminals of the energized equipment. Lightning protectors shall be provided for all power lines at their first point of entry into the equipment, and at their exit from the equipment. the return terminal of the lightning protector shall be connected to earth ground via a separate dedicated conductor no less than a No. 6 American Wire Gage (AWG).

3.8 Interference requirements.- Conducted interference levels on the power leads, control leads, signal leads, and interconnecting cables between parts, shall not exceed the limits for CE03, as defined in MIL-STD-461 (equipment class ID). Similarly, radiated narrowband and broadband interference levels shall not exceed the limits for RE02 of MIL-STD-461 over the frequency range from 14 kilohertz (kHz) to 400 megahertz (MHz) at a distance of 20 feet (6.1 meters).

3.9 Component requirements

3.9.1 Rectifiers.- The direct current voltages for the flash capacitors shall be obtained from a full wave rectifier using solid-state diodes suitable for the intended purpose.

3.9.2 Transformer.- The individual control cabinet power transformer shall conform to MIL-T-27, type TF5RX02, size as required. Voltage taps in 20 volt increments from 200 to 260 volts shall be provided on the primary winding for adjusting input to the identifier unit at 240 volts for any supply voltage within the range. All taps shall be brought out to a terminal block similar or equal to Marathon 1000 series and attached to the transformer with each tap clearly and permanently identified. The secondary shall be center tapped for use with the rectifier in 3.9.1. The secondary winding shall be rated at 250 milliamperes direct current (dc) and such voltage as necessary to provide a dc voltage of 2,000 volts at 240 volts input.

3.9.3 Flash capacitors.- All flash capacitors shall be rated at 2,500 volts dc minimum and shall be designed for the intended application. They shall have a life expectancy of 1 year of continuous duty at a normal working voltage of 2,000 volts dc. No electrolytic capacitors of any type shall be used.

3.9.4 Interlock switches.- Interlock switches shall be incorporated in the identifier unit, the individual control cabinet, and the control cabinet. When the units are opened, the interlock switches shall:

(a) Disconnect all incoming power and control circuits, except the incoming power to the maintenance light and convenience outlet (3.4.1.10).

(b) Discharge all flash tube capacitors (individual control cabinet only) through a relay to a maximum value of 50 volts within 30 seconds. This requirement shall apply even if components that normally draw current from the high voltage circuits are removed.

In addition, the design shall provide for permanently connected bleeder resistors in the individual control cabinet to discharge the flash tube capacitors to a maximum value of 50 volts within 1 minute in event of failure of the interlock switches. Means shall be provided to enable the interlock switches to be cheated when the units are opened.

3.9.5 Lightning arresters.- Lightning arresters shall be provided for all underground conductors and shall be installed as near as possible to their point of entrance to the housing. The arresters shall be properly combined where necessary to meet the circuit voltage requirements.

3.9.6 Relays.- The flash tube trigger relay shall be the plug-in type to fit a standard octal socket and shall be enclosed in a dust cover.

3.9.7 Test points and controls.- Test points shall be provided on all signals that are required to be monitored during checkout, alignment, calibration, or during preventive maintenance procedures. Test points shall not be located in compartments with voltage points of 500 volts or more, and all test points shall be located so as to preclude accidental shock to personnel engaged in normal operating or maintenance activities. The removal of components, modules, or circuit cards shall not be required to gain access to test points or adjustments. Test point controls and indicators mounted on printed wiring boards shall be accessible from the front of the circuit cage assembly without the use of extender boards.

3.9.7.1 Remote maintenance monitoring and control.- Test points for the power and control signals (listed below) of the control cabinet shall be terminated in a central location within the cabinet. The termination shall be in a female connector to allow easy connection to an external remote maintenance monitoring system and for use during preventive maintenance procedures.

(a) Power supply outputs.

(b) Output power to individual control cabinets.

(c) Intensity control signals (low, medium, high) to individual control cabinets.

(d) Trigger signal to individual control cabinets.

(e) Two monitor signals from the individual control cabinets.

(f) Misfire detection signals.

(g) Neutral or Ground.

3.10 Materials.- Materials shall be as specified herein. Materials and parts not specifically designated by part number, standard, or specification, shall be in accordance with Specification FAA-G-2100c, paragraphs 3.6 through 3.6.11. All components and parts shall be suitable for operation under the environmental conditions specified in 3.6. Metal parts shall be either inherently corrosion-resistant or shall be suitably protected to resist corrosion or oxidation during extended service life. The use of dissimilar metals in contact with one another shall be avoided wherever practicable. However, if their use cannot be avoided, they shall be used in accordance with MIL-STD-889. All equipment components in the identifier units, as defined herein, and furnished under this specification shall be interchangeable without alterations in circuitry for power or control. The components of the entire assembly shall be directly interchangeable with any other identifier furnished under this specification.

3.10.1 Printed wiring boards (pwb).- All electronic components of the REIL system, except power devices, shall be mounted on printed wiring boards. Conformal coating of pwb's is required and shall be Type AR in accordance with MIL-I-46058.

3.10.2 Metals.- Metals shall withstand the mechanical stress involved and shall be inherently corrosion resistant, or suitably protected after fabrication, to prevent corrosion or oxidation under the service conditions.

3.10.2.1 Ductile iron.- Heat-treated ductile iron, if used, shall have the proper tensile and yield strength to meet the requirements set forth herein. Particular attention shall be paid to the proper Brinell hardness and elongation of the material. Protection plating as specified in 3.10.3.2 shall be used on all cast and machined ductile iron surfaces.

3.10.2.2 Stainless steel.- Type 18-8 stainless steel shall be used for all bolts, nuts, and washers not subject to high stress requirements. At the option of the contractor, stainless steel may be used for any purpose for which another material is not definitely specified elsewhere herein or elsewhere in the contract specifications, provided that all stainless steels are of the following types:

American Iron and Steel Institute (AISI)
Type Numbers

301	305	316L
302	308	317
302B	309	321
303	310	322
304	314	322A
304L	316	347

3.10.2.3 Aluminum.- Aluminum, when used, shall be in accordance with Federal Specifications QQ-A-200/9 and QQ-A-225. Aluminum alloy plate and sheet, aluminum alloy die castings, and aluminum alloy sand castings shall be in accordance with Federal Specifications QQ-A-250, QQ-A-591, and QQ-A-601, respectively. Aluminum alloy castings, when used, shall be impregnated in accordance with MIL-STD-276.

3.10.3 Protective coatings.- Protective coatings used for prevention of corrosion shall be as specified herein.

3.10.3.1 Anodizing.- Aluminum parts on the exterior of the identifier unit that would be exposed to continuous moisture, salt-laden atmosphere, or mechanical damage, shall be teflon penetrated, hardcoat anodized, and shall meet the requirements of MIL-A-8625, Type I or Type II, Class 1 or Class 2, as applicable.

3.10.3.2 Plating.- All iron and steel parts used shall be zinc or cadmium-plated in accordance with Federal Specification QQ-Z-325 or QQ-P-416.

3.10.3.3 Painting.- The individual components of the REIL system enumerated below shall be painted as follows: All exposed surfaces of the control cabinet (3.4.1) and the identifier unit (3.4.2.4) shall be protected by not less than a primer coat, a body coat, and a final coat of paint. The final coat shall be aviation surface orange color with the paint meeting the requirements of Federal Specification TT-E-489. Color shade shall be aviation gloss orange No. 12197, Federal Standard 595. The final painted surfaces shall be free of blotches, scratches, and runs.

3.10.4 Gaskets.- Gaskets used at separable joints for cushioning and sealing purposes shall be continuously molded neoprene and shall be capable of sustained operation at ambient temperatures of -55° C (-67° F) to +70° C (+158° F).

3.10.5 Adhesives.- Adhesives, when used, shall be in accordance with MIL-STD-454, requirement 23.

3.10.6 Electrical insulating materials.- Insulators, insulating, and dielectric materials shall be in accordance with MIL-STD-454, requirement 11.

3.11 Processes

3.11.1 Brazing.- Brazing shall be in accordance with MIL-STD-454, requirement 59, except that electrical connections shall not be brazed. Paragraph 3.3 of requirement 59 is not applicable.

3.11.2 Cabling.- Wiring shall be in accordance with the requirements of FAA-G-2100c, paragraph 3.5.38.

3.11.3 Cable breakout wires.- Each individual breakout wire lead that emerges from a cable shall be longer than necessary for its termination with approximately 1 inch (25 mm) of slack wire neatly formed adjacent to its termination.

3.11.4 Soldering.- Soldering shall be in accordance with MIL-STD-454, requirement 5.

3.11.5 Lugs connected to screw terminals.- When solder or solderless lugs are used to terminate wires, only one wire shall be connected to each lug. The lugs shall be clamped under screw terminals; not more than three lugs shall be clamped under one screw terminal. Individual wires shall be removable from the screw terminal by loosening or removing the screw.

3.11.6 Cable connector wiring.- No more than one wire shall be attached to each contact or each cable connector, except that two wires may be attached to a crimp-type contact. The two wires connected together shall not exceed the size of the connector pin.

3.11.7 Splices.- Wires and cables shall not be spliced.

3.12 Parts rating.- All parts shall be of adequate rating for the application and shall not be operated in excess of the parts manufacturer's recommended ratings during operation of the equipment throughout the specified environmental range (3.6). Components within the control cabinet (3.4.1) shall be derated as required by the interior temperature rise above the maximum outside ambient temperature at 10,000 feet (3,048 meters) altitude.

3.13 Assembly and marking.- All components shall be properly assembled and marked. Each electrical component or part thereof shall be identified by a reference designation marked adjacent to the physical location of the part in the equipment and readily visible to maintenance personnel. Such identification shall be identical to reference designations used in instruction books for the equipment. Where possible, all wiring shall be grouped, color coded, laced into cables, neatly clamped, and properly marked. Marking shall be in accordance with Specification FAA-G-2100c as applicable.

3.14 Nameplate.- Each cabinet and housing shall be furnished with a standard nameplate, in accordance with FAA Drawing C-21216, fastened to its outside surface with Type 430 or 18-8 stainless steel rivets or drive screws in accordance with Specification FAA-G-2100c, paragraph 3.10.

3.15 Workmanship.- Workmanship shall be in accordance with MIL-STD-454, requirement 9.

3.16 Reliability

3.16.1 Reliability design criteria.- The following equipment shall meet the listed reliability requirements:

Equipment	Specified Mean Time Between Failures (MTBF)
(a) Control cabinet	2,500 hours
(b) Individual control cabinet	2,500 hours

3.16.2 Reliability program

3.16.2.1 Organization.- The head of the reliability management organization shall have the necessary authority, resources, and access to higher management to enable him to implement and enforce the requirements specified herein.

3.16.2.2 Subcontractor and supplier reliability program control.- Subcontractors and suppliers shall be bound by the same reliability requirements as the contractor. Any deviations shall be presented to the FAA program office for review and approval.

3.16.2.3 Reliability predictions.- Reliability predictions shall be based on the proposed design and mathematics model of the system element for each mission profile and mode of operation. Predictions shall conform to the requirements for predictions, paragraph 5.2.2.3 specified in MIL-STD-785, and the following:

(a) Apportion required system probability of mission success to each function.

(b) Determine the reliability of hardware items and other system elements executing or supporting each function.

(c) Reliability estimates and predictions shall be made relating to the mathematical model such as those contained in MIL-HDBK-217b. Current estimates and predictions shall be made for each mission or mode of operation. Where other equipments (Government or contractor furnished) are to be integrated, data furnished by the Government on known or estimated values of reliability shall be used as applicable in the contractor's judgment.

(d) The reliability of the equipment shall be predicted based on the stresses experienced by the parts using the failure rate information contained in MIL-HDBK-217b and in the Nonelectronic Reliability Notebook, RADC-TR-75-22. No other source of part failure rates shall be used unless specifically approved by the procuring activity. The prediction techniques in the following paragraphs shall be implemented by the contractor.

3.16.2.3.1 Average stress prediction.- The reliability of the system shall be predicted using average part failure rates in conjunction with generalized part application assumptions. The prediction shall be submitted in accordance with the contract schedule.

3.16.2.3.2 Detailed stress prediction.- The reliability for the system shall be predicted based on failure rates determined from either measured or computed stress for each part used in the system. Detailed reliability stress analysis shall be performed in accordance with MIL-HDBK-217b. The predictions shall be based upon the maximum temperature rise specified in the detailed specification. An initial stress analysis prediction shall be submitted 15 days prior to the Critical Design Review (CDR). The prediction shall be revised, as necessary, during the course of the system development and production effort to reflect any design changes and part substitutions.

3.16.2.4 Parts control task.- All reliability requirements placed upon the contractor are equally applicable to subcontractors/vendors. The reliability manager shall be responsible for assuring compliance and for assuring that the appropriate requirements are placed in subcontractor specifications.

3.17 Maintainability

3.17.1 Maintainability design criteria.- The following equipment shall meet the listed maintainability requirements:

Equipment	Mean Time to Repair (MTTR)	Maximum Repair Time
(a) Control Cabinet	0.5 hour	6 hours
(b) Individual control cabinet	0.5 hour	4 hours

3.17.2 Maintainability program

3.17.2.1 Maintainability program management.- The contractor shall have one clearly identified organizational element which shall be responsible for planning, implementing, controlling, and reporting all maintainability tasks required by this specification.

3.17.2.2 Organization.- The head of the maintainability management organization shall have the necessary authority and resources and access to higher management to enable him to implement and enforce the requirements specified herein. The maintainability management organization may be part of the reliability management organization.

3.17.2.3 Maintainability predictions.- The contractor shall predict maintainability values for the system/equipment. The prediction technique specified shall be used. The prediction technique shall estimate quantitatively the maintainability system/equipment parameter values for the planned design configuration. The quantitative estimates shall be used to judge the adequacy of the proposed design to meet the maintainability quantitative requirements and to identify design features requiring corrective action.

3.17.2.3.1 Early design predictions.- During the early design and development stages, prediction of mean corrective maintenance time shall be prepared and performed in accordance with procedure III of MIL-HDBK-472. The prediction shall be submitted 15 days prior to preliminary design review (PDR).

3.17.2.3.2 Final design predictions.- During the final design stages of development, predictions of mean corrective maintenance time shall be in accordance with procedure II of MIL-HDBK-472. The prediction shall be submitted 15 days prior to critical design review.

3.18 Documentation

3.18.1 Instruction book manuscript.- Instruction book manuscripts shall be prepared as required herein.

3.18.1.1 Draft manuscript.- A draft manuscript of the instruction book covering the entire system shall be prepared and submitted in accordance with the requirements of FAA-D-2494/1a except that:

(a) Functionalization, keying, and shading of drawings and text is not required. Theory of operation shall be explained at the hardware level; however, simplified schematic or functional diagrams may be used to explain unusual or complex circuits.

(b) Integrated circuit chip details, boolean algebra expressions, and truth tables are not required (reference: FAA-D-2494/1a, figure 12).

(c) Blocked schematic or major function diagrams are not required (reference: FAA-D-2494/1a, paragraphs 1-3.9.2.2 and 1-3.9.2.3); however, system block diagrams (reference: FAA-D-2494/1a, paragraphs 1-3.9.3.5 and 1-3.9.3.6) and schematic diagrams shall be provided.

(d) Printed circuit board illustrations shall be required only to show component placement and reference designations. Circuit wiring paths need not be provided.

(e) Logic principles specified in FAA-D-2494/1a, paragraph 1-3.9.6, are not required.

(f) Integrated circuit internal details specified in FAA-D-2494/1a, paragraph 1-3.14.5.1, are not required.

3.18.1.2 Final manuscript.- Final camera-ready manuscripts shall be provided as required by FAA-D-2494/2a.

3.18.2 Instruction books.- The Government will reproduce and prepare instruction books from the camera-ready manuscript and furnish copies to the contractor for shipment with the equipment. Two instruction books shall be included with each set of equipment comprising a system.

3.19 Configuration management.- The contractor shall implement a configuration managment program in accordance with FAA-STD-021. As a minimum, the contractor shall submit, within 30 days after receipt of contract, a configuration management plan for review and approval by the Government.

4. QUALITY ASSURANCE PROVISIONS

4.1 Quality control provisions.- The contractor shall provide and maintain a quality control program in accordance with FAA-STD-013. All tests and inspections made by the contractor shall be subject to Government inspection. The term "Government inspection," as used in this specification, means that an FAA representative will witness the contractor's testing and inspection, and will carry out such visual and other inspection as deemed necessary to assure compliance with contract requirements.

4.2 Notification of readiness for inspection.- After receipt of approval of test procedures and test data forms (FAA-STD-013), the contractor shall notify the Government Contracting Officer in writing that he is ready for Government inspection. Such notification shall be given in time to reach the Contracting Officer not less than 5 work days before the contractor desires inspection to start.

4.3 Invoice submission.- Prior to the first inspection, the contractor shall submit to the FAA representative copies of invoices covering shipment of each item from the supplier's plant to that of the primary contractor. Each invoice shall carry the vendor's certification that each item furnished meets the requirements of this specification. The certification shall be traceable to the part or material manufacturer's quantitative test data pertaining to the specific part or material. Vendor certification does not constitute FAA acceptance of any part or unit of equipment provided under this specification nor release that part or unit from acceptance testing by the contractor.

4.4 Test methods.- Testing of the equipment shall be performed in two categories as described below.

4.4.1 Design qualification test.- The first unit of production of each component is designated as the production model. Where the complement of a system and the prescribed manner of testing requires the initial production of a group of identical units, e.g., two identifier units, then all members of that group will be referred to hereinafter as the production model. The production model shall be subjected to the tests specified in 4.5, as required by table III. At the conclusion of each test specified in 4.5.1 through 4.5.12, the production model shall undergo at least two cycles of the operational test (4.5.13.1). Failure of the equipment to meet the performance requirements specified herein shall be cause for rejection.

4.4.2 Production unit tests.- Testing of the production units shall start after acceptance of the production model. Tests on production units shall be as specified in 4.5 and as required by table III.

Table III. Qualification and Production Tests

Test	Control Cabinet	Individual Control Cabinet	Identifier Unit	Power Adapter	Aiming Device	Site Spare Parts
Visual inspection (4.5.1)	X*	X*	X*	X*	X*	X*
Humidity (4.5.2)	X	X	X	X		
Altitude (4.5.3)	X	X	X	X		

X = Design qualification test (production model).
* = Production unit test.

Table III. Qualification and Production Tests - Continued

Test	Control Cabinet	Individual Control Cabinet	Identifier Unit	Power Adapter	Aiming Device	Site Spare Parts
Temperature (4.5.4)	X	X	X	X		
Sand and dust (4.5.5)	X	X	X	X	X	
Salt spray (4.5.6)	X	X	X	X	X	
Rain (4.5.7)	X	X	X		X	
Submersion (4.5.8)				X		
Solar radiation (4.5.9)	X	X	X			
Vibration (4.5.10)	X	X	X			
Transient suppression (4.5.11)	X	X				
Interference (4.5.12)	X	X				
150-hour test (4.5.13.1)	X	X	X	X		
2-hour test (4.5.13.2)	*	*	*	*		*
Power adapter operation (4.5.14)				*		
Photometric (4.5.15)			X*			

X = Design qualification test (production model).
* = Production unit test.

Table III. Qualification and Production Tests - Continued

Test	Control Cabinet	Individual Control Cabinet	Identifier Unit	Power Adapter	Aiming Device	Site Spare Parts
Thermal shock (4.5.16)			X			
Dielectric test (4.5.17)	X*	X*	X*	X*		
Maintainability demonstration (4.5.18)	X	X		X		

X = Design qualification test (production model).
* = Production unit test.

4.5 Tests

4.5.1 Visual inspection.- The equipment shall be visually inspected for workmanship, fabrication, finishing, painting, and adequacy of selected parts.

4.5.2 Humidity test.- The humidity test shall be in accordance with Procedure I, Method 500, of MIL-STD-810C, except that a total of three complete cycles (72 hours) will be required and the maximum temperature shall be +70° C (158° F).

4.5.3 Altitude test.- The altitude test shall be in accordance with Procedure II, Method 500, of MIL-STD-810C. The equipment shall be tested at atmospheric pressures corresponding to sea level and 10,000 feet (3,048 meters) altitude at both -55° C (-67° F) and +70° C (+158° F).

4.5.4 Temperature test.- The high temperature test shall be in accordance with Procedure II, Method 501, of MIL-STD-810C, except the temperature shall be +70° C (+158° F). The low temperature test shall be in accordance with Procedure I, Method 502, of MIL-STD-810C, except the temperature shall be -55° C (-67° F), with the 2-hour operational test to start 2 hours after temperature stabilization. Do procedure I three times.

4.5.5 Sand and dust test.- The sand and dust test shall be in accordance with Procedure I, Method 510, of MIL-STD-810C. Delete steps 2 and 3, and rotate the equipment 120° twice. Air velocity shall be 2,500 ± 500 feet (762 ± 152 meters) per minute.

4.5.6 Salt spray test.- The salt spray test shall be in accordance with Procedure I, Method 509, of MIL-STD-810C, except that the relative humidity shall be up to 95 percent. The test shall be for not less than 168 hours. Salt buildup as a result of the test may be removed with tapwater.

4.5.7 Rain test.- The rain test shall be in accordance with Procedure I, Method 506, of MIL-STD-810C.

4.5.8 Submersion test.- The production model 6.6 and 20 ampere power adapters shall be submersion tested in accordance with MIL-STD-810C under 24 inches (0.6 meters) of water for 8 hours. The adapter shall be operating for the first 4 hours of the test and shall be off for the last 4 hours. The power adapter transformer shall be submersion tested alone (out of adapter), as specified above, to demonstrate that the primary circuit is waterproof and insulated.

4.5.9 Solar radiation (sunshine) test.- The solar radiation test shall be conducted in accordance with Procedure II, Method 505.1, of MIL-STD-810C. The equipment shall be operated for 1 hour during the third cycle when the test item has reached its peak temperature.

4.5.10 Vibration test.- The equipment shall be vibration tested to meet the requirements of 3.6.9.

4.5.10.1 Vibration planes.- The test assembly shall be vibrated in three planes or directions as follows:

(a) In a direction perpendicular to the test table (vertically).

(b) Horizontally, parallel to the light beam axis.

(c) Horizontally, at right angles to the light beam axis.

4.5.10.2 Frequencies.- The test assembly shall be vibrated through a frequency range of 10 to 2,000 cycles per second, in each plane, until the accelerations shown in table IV are reached. Duration of each sweep shall be 10 minutes. Electrical continuity through the lamp shall be continuously monitored under full load conditions. If the gas tube or lamp envelope fails at any point in the range of frequencies, the test shall be continued and completed on the fixture alone. Then a new lamp shall be installed and the fixture assembly shall again be vibrated in three planes through the frequencies of 55 to 2,000 cycles at 3 gravities. Failure to meet these requirements shall be cause for rejection of the fixture or the lamp mounting, or both.

Table IV. Vibration Test Data

Acceleration in Gravities	Frequency, Hertz
0.020 inch double amplitude (displacement)	10-70
5	70-200
10	200-500
15	500-2,000

After the vibration test, the equipment shall be thoroughly examined for mechanical failure of any component, loosening of any part, cracked or broken seals, continuity of electrical circuits, and possible damage to the lamp envelope, supports, etc.

4.5.11 Transient suppression test.- The control cabinet and the individual control cabinet shall be connected as shown in figure 2 or 3, as applicable, and tested to verify conformance with the transient suppression requirements of 3.7. A surge generator shall be set to superimpose transient levels, described in 3.7, on the energized ac power line and control signals output line (excluding remote maintenance monitoring output terminals) of the equipment. These levels shall be verified by open-circuit and short-circuit tests prior to testing the equipment. The surge generator, with a preset transient control level, shall then be connected to the input power lines and to the output lines of the energized equipment, respectively. A minimum of five test surges for each transient control level shall be superimposed on the input power and output lines of the energized equipment. Test surges shall be applied between each input terminal and ground and each output terminal and ground, as well as between the input terminals of a circuit pair and the output terminals of a circuit pair.

4.5.12 Interference test.- The control cabinet and the individual control cabinet shall be connected as shown in figure 2 or 3, as applicable, and tested to verify conformance with the interference requirements of 3.8. Measurement of the electromagnetic emissions shall be in accordance with test method CE03 of MIL-STD-462. Measurement of the radiated emission shall be in accordance with test method RE02 of MIL-STD-462.

4.5.13 Operational test.- The control cabinet and identifier unit shall be connected as shown in figure 2 or 3, as applicable, and operated for a period of 1 hour. The input to the current sensor shall be through an isolation transformer (in accordance with AC 150/5345-47) and its primary current shall be varied from 0 to 7 amperes to check for proper operation of the sensor. Operation of the identifier unit shall be attempted with the interlock switches in the open position to verify proper operation of the interlock. A test shall be made to check the intensity step functions of the identifier unit. All operating requirements of the equipment shall be checked. Voltage and current shall be recorded for the input power, input to the current sensor, and output of the control cabinet, for each intensity step.

4.5.13.1 The 150-hour test.- A 150-hour continuous operation test shall be performed on the production model. All intensities shall be checked using the remote control inputs to cycle the system as follows:

(a) Low intensity, 5 minutes, ±1 minute

(b) Off, 2 seconds, maximum

(c) Medium intensity, 5 minutes, ±1 minute

(d) Off, 2 seconds, maximum

(e) High intensity, 5 minutes, ±1 minute

(f) Off, 60 seconds, ±10 seconds

(g) Repeat cycle, starting with (a)

The local control switch shall be manually cycled through the low, medium, and high intensity step positions a minimum of 20 times at the completion of the 150-hour test. Flash tubes used in the 150-hour test shall not be a part of the FAA procurement and shall be replaced with new flash tubes prior to system delivery.

4.5.13.2 The 2-hour test.- Production units shall undergo a 2-hour continuous operational test using the remote control inputs as follows:

(a) High intensity, 1 hour, ±2 minutes

(b) Cycle in accordance with 4.5.13.1(a) through (g), 1 hour, ±2 minutes

The local control switch shall be manually cycled through the low, medium, and high intensity positions a minimum of 20 times at the completion of the 2-hour test.

4.5.14 Power adapter operation test cycle.- Each production unit power adapter shall be operated through the following cycles during a 2-hour continuous test. Power input shall be provided by a constant current edge light circuit as specified in 3.4.3.3.1 for a 6.6 ampere adapter and as specified in 3.4.3.3.3 for a 20 ampere adapter. The adapters shall be connected as shown in figures 3 and 4 and tested as described below. The power adapter output voltage shall be measured at each intensity step of the runway edge lighting circuit and shall be 240 V, ±24 V ac. Shown below are values of current which will be encountered in series runway edge lighting circuits.

	REIL	Edge Circuit Current Value* (HIRL)	Duration
(a)	Off	6.6/20.0 amperes	1 minute, ±1 minute
(b)	On	6.6/20.0	10 minutes, ±1 minute
(c)	On	5.2/15.8	10 minutes, ±1 minute
(d)	On	4.1/12.4	10 minutes, ±1 minute
(e)	On	3.4/10.3	10 minutes, ±1 minute
(f)	On	2.8/8.5	10 minutes, ±1 minute
(g)	Repeat (a) through (f) one time		

	REIL	Edge Circuit Current Value (MIRL)	Duration
(a)	Off	6.6 amperes	1 minute, ±1 minutes
(b)	On	6.6	10 minutes, ±1 minute
(c)	On	5.5	10 minutes, ±1 minute
(d)	On	4.8	10 minutes, ±1 minute
(e)	Repeat (a) through (d) one time		

*Values at left are for a 6.6 ampere circuit; values at right are for a 20 ampere circuit.

4.5.15 Photometric test.- Tests shall be conducted on the identifier unit to prove conformance with all photometric requirements. Determination of effective intensity shall be in accordance with FAA-E-1100.

4.5.16 Thermal shock test.- The production model shall be installed as in normal use and operated at maximum intensity until the temperatures have stabilized. At least 3 gallons of water at a temperature of 0 to +5° C (32° to +41° F) shall be sprayed on the top surface. There shall be no cracking of glass or metal.

4.5.17 Dielectric test.- The production model shall be subjected to 60 hertz dielectric tests using twice circuit voltage plus 1,000 volts for a period of 1 minute. Any evidence of current leakage in excess of one milliampere shall be cause for rejection. After completion of the dielectric test, a 1,000 V dc insulation tester shall be used to check the same points. The resistance to ground, as observed with the insulation tester, shall not be less than 30 megohms. Components not designed for this high voltage, such as small capacitors, rectifiers, etc., may be disconnected for this test. Production units shall be checked with the insulation tester.

4.5.18 Maintainability demonstration tests.- Maintainability demonstration tests shall be performed in accordance with MIL-STD-471 to verify all quantitative maintenance values required by the specification.

4.5.19 Site spare parts test.- Spare printed circuit boards shall be tested as part of a unit and shall be subjected to the tests specified in table III, as applicable.

4.6 Test instruments.- The manufacturer or the testing laboratory performing preproduction tests shall provide adequate instrumentation for these tests. All instruments shall have calibration labels indicating that the instruments have been calibrated by a reliable laboratory within a period of 6 months prior to the beginning of tests on the REIL equipment. Oscilloscopes and photometric equipment shall be calibrated prior to performing the first test, and if necessary, every 3 months after completion of the first test. Indicating instruments, voltmeters, and ammeters shall be of the 1/2 of 1 percent classification or better. Alternating current instruments shall be true types. Temperature sensing elements shall be thermocouples. Each thermocouple shall be pretested by inserting it in a chamber of known temperature. The thermocouples shall be installed at points determined by the FAA representative. The thermocouples shall be secured in place with high temperature cement manufactured for this purpose (Sauereisen cement or equal).

4.7 Test performance.- All tests described above shall be performed at the contractor's expense at the contractor's facility or at an FAA-approved independent testing laboratory.

5. PREPARATION FOR DELIVERY

5.1 General.- All components that form a part of a particular system and are tested together shall be shipped together. Each system shall be prepared for domestic shipment in accordance with the following subparagraphs.

5.1.1 Packaging.- Packaging shall be in accordance with specification MIL-E-17555 for equipment of this classification. All loose items shall be securely fastened prior to shipment.

5.1.2 Packing.- Packing shall be in accordance with specification MIL-E-17555, Level A.

5.1.3 Marking.- All shipments and packages shall be durably and legibly marked with the following instructions:

Quantity____________________
Type____________________
Style____________________
Specification Number__________
Contract Number_____________
National Stock Number_________
Manufacturer's Name or Trademark_____

6. NOTES.- The contents of the subparagraphs below are only for the information of the Contracting Officer. They are not contract requirements, and are not binding on either the Government or the contractor except to the extent that they may be specified elsewhere in the contract as such. Any reliance placed by the contractor on the information is wholly at the contractor's own risk.

6.1 Deliverable items.- The following items are to be called out in the contract documents as deliverable items under this specification:

(a) Identifier assemblies

(b) Control cabinet

(c) Site spare parts

(d) Instruction book

(e) Configuration management plan

(f) Maintainability program plan

(g) Reliability program plan

(h) Maintainability demonstration test plan

(i) Reliability demonstration test plan

(j) Power adapter (if applicable)

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